

S O U T H W E S T R E S E A R C H I N S T I T U T E
8500 Culebra Road, San Antonio 6, Texas

Department of Engineering Mechanics

DEVELOPMENT OF OPTIMUM TECHNIQUES FOR
THE LONG-TIME STORAGE AND PRESERVATION
OF DISC AND MAGNETIC-TAPE AUDIO TRANSCRIPTIONS

Proposal No. 2-184

Prepared for
The Library of Congress
Washington, D. C.

Att: Dr. Harold Spivacke, Chief
Music Division

February 10, 1957

Prepared by:

A handwritten signature in dark ink, appearing to read "Martin Goland", written over a horizontal line.

Martin Goland,
Vice President

PURPOSE

As its principal objective, the research described in this proposal is aimed toward the development of suitable techniques for the storage and preservation of disc and magnetic-tape audio transcriptions, with particular reference to the collection of the Library of Congress, Music Division. Specific interest is to be concentrated on pressed discs, instantaneous discs, and magnetic tape.

In order to accomplish the project objectives, it will be necessary to study the mechanical, physical, chemical and biological properties of the materials used as a recording base. When a suitable understanding has been gained of these properties, it will be possible to design storage facilities which will insure long life with a minimum compromise in the interests of library shelf-availability.

DISCUSSION

This proposal has been prepared at the request of the Music Division, Library of Congress. The scope of the program has been defined by staff members of the Library of Congress, and the technical ideas were jointly conceived by them, the staff of Southwest Research Institute, and a group of consultants under the direction of Dr. William A. Prager, Providence, Rhode Island.

In the event the program is undertaken, it is planned that the Library of Congress will retain overall control of the project objectives, with technical responsibility divided between Dr. Prager and his associates, and the staff of Southwest Research Institute.

The need for the research arises from the fact that the Library of Congress collection of audio transcriptions represents a national, artistic, and historical

heritage whose preservation is of the utmost importance. Practically nothing, however, is known about the most suitable equipment and environment to insure the maximum "life" of the collection. The "life" of a transcription can only be defined in general terms, but carries the implication that the transcription quality and utility will not be degraded to an unacceptable extent.

If the present program is successful, a storage technique will be developed which accounts for the various influences affecting the life of the collection, and which reaches an optimum compromise between shelf life, storage cost, and ready shelf-availability.

DETAILED PROGRAM

From discussions with representatives of the Library of Congress, the present program has been limited to the following types of audio transcriptions:

A. Discs

1. Pressed discs, including plastic, shellac and the more common variants of these items.

2. Instantaneous discs. Of primary concern is the "acetate" disc, which is actually made from cellulose nitrate. It is of interest to note that about 80% of the present Library collection falls in this category.

B. Magnetic Tapes

Since these two transcription media require somewhat different research treatment, the proposed program for each is discussed separately.

Research on Disc Storage Requirements

The investigation would embrace the following broad technical categories: mechanical properties, physical properties, chemical properties, and biological

considerations. Each will now be discussed briefly.

- (a) Mechanical considerations will be concerned largely with the dimensional stability of the items under conditions of long-term storage. Such factors as disc warping, creep distortion, and gradual degradation of the quality of the audio grooves will be studied.

The initial step in this branch of the investigation will consist of the determination of the long-time creep and warping characteristics of the materials and configurations of interest. This data will have to be extracted from the literature, developed by theoretical reasoning, or else measured by controlled experimentation. The distortion and creep of the discs resulting from such techniques as edgewise storage, flat-wise storage, storage under pressure on the two sides, etc., must be evaluated. In addition to studying disc warping, such factors as radial shrinkage or expansion (particularly if this does not occur uniformly about the axis of rotation), and groove degradation must be studied.

A variety of test discs will undoubtedly be employed as experimental aids in the program. For example, test discs prepared by impressing a single (or possibly a multiple) frequency over the playing area can be subjected to various mechanical environments and a direct check made of the resulting audio degradation.

It is evident that storage temperature, and possibly storage humidity, will be controlling factors in determining creep magnitudes, and all tests will have to be conducted under suitably controlled conditions.

In order to minimize the amount of experimental testing required, it is planned that every effort will be made to incorporate the available results of creep theory into the present investigation. Through theoretical considerations, it is hoped that the results of accelerated-damage tests can be extrapolated to predict the performance of the discs under long-time storage environments.

- (b) Physical considerations will entail an analysis of the effects of groove degradation on audio quality. Decisions are required as to the permissible extent of audio distortion, and the relationship between this factor and the permissible extent of dimensional instability. A statistical conclusion will undoubtedly be required, interrelating radial dimension tolerances, warping tolerances, and groove distortion.

Various unconventional storage approaches will also be explored. For example, it is possible that creep distortions of the discs can be minimized by irradiation of the disc, thus hardening the disc material.

- (c) Chemical considerations will entail the identification of the materials from which the items are normally fabricated, and a literature (and possibly laboratory) study to assess the chemical ageing characteristics of each material.

Of principal interest are such factors as changes in material properties with age, the chemical effects of temperature and humidity, the effects of dust and other atmospheric pollutants, the effects of exposure to light, etc.

- (d) Biological considerations will be concerned with the prevention of accumulations of fungus and other bacterial agents during long-time storage. This may entail the proper choice of materials which are in contact with the stored item, control of the storage environment, or both.

Research on Magnetic Tape Storage Requirements

The general approach to the magnetic tape studies will parallel the outline given for discs. Thus, suitable mechanical, physical, chemical and biological investigations will be made.

Mechanical considerations will involve study of the dimensional stability and creep deformations of magnetic tapes under storage conditions.

Physical investigations will receive considerable emphasis, since such questions as "print-through" of magnetic tapes, the life of the tape recordings, the effects of stray atmospheric and magnetic phenomena, the effects of vibration, etc., will require clarification.

Chemical and biological studies will essentially follow the outline presented earlier for discs.

The Development of Suitable Storage Techniques

With the properties of the transcription media known, this information must be integrated into a design study of the equipment and procedures which will insure long storage life.

The factors which enter the final decision as to storage techniques include not only the storage life which is to be achieved, but also the shelf availability of the items, the initial cost of establishing the storage environment, and the operating costs to maintain the storage facilities. A compromise between these factors will undoubtedly be required, and this will entail the exercise of considerable discretion on the part of those directing the program.

It is planned that a series of storage techniques will be studied, with engineering designs and specifications prepared for the associated equipment. During the course of this work, as much help and advice as possible will be solicited from suitable and interested equipment manufacturers, and from other outside sources.

At the conclusion of the research, specific recommendations will be made regarding storage procedures which will best meet the needs of the collection of the Library of Congress.

ADMINISTRATION OF THE PROGRAM

As mentioned earlier, the overall program objectives will be under the control of the Music Division, Library of Congress.

Technical responsibility will be held jointly by Southwest Research Institute and a group of consultants under the direction of Dr. William A. Prager, Providence, Rhode Island. The project consultants will aid in the planning for the work, the development of suitable experimental approaches, and the theoretical extrapolation of accelerated-damage tests to long-time storage conditions. They will also supply other help to the program as would seem justifiable during the course of the work.

Reports covering progress of the research will be issued to the Library by Southwest Research Institute. Bi-monthly letter reports will be alternated with bi-monthly historical reports, describing in detail the results obtained during the past work period and plans for the future studies.

The written reports will be supplemented by regular meetings of a Project Planning Committee. Members of this committee will include, among others to be added later, Dr. Spivacke, Dr. Prager, and Mr. Martin Goland of Southwest Research Institute.

The final report for the project will be issued in two parts. Part I will contain a detailed account of all research accomplished and conclusions drawn, with supporting data given in detail. Part II will be a general summary of the project research and conclusions, suitable for release to semi and non-technical personnel who can benefit from the research findings. The release of all material to persons not directly concerned with the project will be under the direct control of the Library of Congress.

It is clear that the successful prosecution of the program will require that a team approach be employed, in which the aid of virtually all branches of scientific

skills are enlisted. Southwest Research Institute is ideally staffed to insure that this will be done, in view of the comprehensive character of its research and development services to industry, the government, and the public at large.

BUDGET and TIME REQUIREMENTS

It is estimated that approximately 12 months will be required for completion of this program. Costs are estimated as follows:

Library of Congress

Administrative Direction	\$ 2,500
Preparation and Procurement of Test Records	3,800
Travel, Telephone, etc.	1,200
Contingencies and Miscellaneous	2,500

TOTAL

\$ 10,000

Consultants (no SwRI surcharge will be added)

\$ 5,000

Southwest Research Institute

1. Professional Services:

Engineering	\$ 8,000
Physics	8,000
Chemistry	3,000
Biology	2,000
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	\$ 21,000

2. Machine Shop:

Modification and Construction of Facilities	\$ 1,000
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3. Total Estimated Direct Labor Costs	\$	22,000	
4. Overhead (100% of Line 3)*	\$	22,000	
5. Total Direct Salary Costs			\$ 44,000
6. Services - Photographic, Reproductions	\$	300	
7. Materials & Supplies		1,800	
8. Telephone & Telegraph		150	
9. Travel <i>related to this project</i>		850	
10. Total (Items 6 through 9) Direct Cost	\$	3,100	
11. Total Labor and Direct Costs			\$ 47,100
12. Fixed Fee (6% of Item 11)			\$ 2,826
13. Total (Items 11 and 12)			\$ 49,926
TOTAL ESTIMATED COST			<u>\$ 64,926</u>

*Provisional rate (based upon current fiscal year costs) subject to adjustment to actual rate as determined by audit in accordance with ASPR, Section XV, Part 2. The actual audited rate for Fiscal Year ended September 30, 1955 is 107.76%.

CONTRACTUAL INFORMATION

Southwest Research Institute is a Trust Estate organized and existing under the laws of the State of Texas with its principal place of business at 8500 Culebra Road, San Antonio, Texas. The Institute presently employs approximately 480 full-time scientists, engineers, technicians and service personnel.

It is desired that a cost-plus-fixed fee contract be provided. Allowable costs would be determined in accordance with Armed Services Procurement Regulations, Section XV - Contract Cost Principles, Part 2. The Institute has established a fixed fee of 6 percent and a provisional overhead rate of 100 percent. An audit by the Office of the Auditor General has shown an overhead rate of 107.76% for the fiscal year ended September 30, 1955. The overhead rate for fiscal year ended September 30, 1956, has not been established.

The cognizant audit agency for all Defense Department contracts is the Auditor General, Southwest District, Kelly Air Force Base, Texas. It is believed possible that this agency could be utilized for audit and verification of this contractor's invoices prior to submission for payment.

Financing to the extent of current payments on account of allowable cost as provided in the clause entitled "Reimbursement" of the General Provisions of a standard CPFF contract will be requested.

This proposal shall remain in effect not longer than 90 days from date of presentation. During this period, work will be initiated within 30 days of receipt of a signed contract.

Personnel to be contacted for any negotiations required on this procurement:

Contractual: Mr. A. C. Hulen, Treasurer, GE 2-5221, Ext. 33

Technical: Mr. Martin Goland, Vice President, GE 2-5221, Ext. 36

CONTINGENT FEE STATEMENT

The bidder (Contractor) represents: (a) that he has not employed or retained any company or person (other than a full-time bona fide employee) working solely for the bidder (Contractor) to solicit or secure this contract, and (b) that he has not paid or agreed to pay to any company or person, other than a full-time bona fide employee working solely for the bidder (Contractor) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating thereto as requested by the Contracting Officer.

(Note: For interpretation of the representation, including the term "bona fide employee", see General Services Administration Regulation, Title 44, secs., 150.7 and 150.5 (d) Fed. Reg. Dec. 31, 1952, Vol. 17, No. 253).

SOUTHWEST RESEARCH INSTITUTE

by: A. C. Hulen
A. C. Hulen
Treasurer

SOUTHWEST RESEARCH INSTITUTE PERSONNEL

As noted earlier, contributions to this research program will be made on a team effort by representatives from a number of different scientific disciplines.

Qualifications are attached of the Chairmen of the various departments involved and of other senior staff members who will participate in this project.

MARTIN GOLAND

Vice President
Southwest Research Institute

M.E., Cornell University, 1940

Special Fields: Applied Mechanics, Applied Mathematics, and Engineering Analysis. Diversified Experience in Structures, Aerodynamics and Fluid Flow, Aircraft Dynamics, Vibration and Impact Problems, and other Engineering Analysis Fields. Experience in Operations Research and Industrial Economics Techniques.

Experience:

Vice President, Southwest Research Institute, 1955 to date. Also, Editor Applied Mechanics Reviews.

Director for Engineering Sciences, Midwest Research Institute, 1950 to 1955. Chairman, Engineering Mechanics Division, 1946 to 1950.

Head, Applied Mechanics Section, Structures Department, Curtiss Wright Corporation, Research Laboratory, Airplane Division, 1942 to 1946.

Instructor in Mechanics of Engineering, Cornell University, 1940 to 1942.

Publications: Numerous publications in fields of special abilities (see above).

Patents: Automatic Measuring Apparatus and Method; others pending.

Awards: Spirit of St. Louis Junior Award, American Society of Mechanical Engineers, 1944; Junior Award, American Society of Mechanical Engineers, 1946; Alfred Noble Award, American Society of Civil Engineers, 1947.

Member: American Society of Mechanical Engineers; Institute of Aeronautical Sciences; Society for Experimental Stress Analysis; Member, Committee on Aircraft Construction of the National Advisory Committee for Aeronautics; Chairman of Sub-Committee on Vibration and Flutter, N.A.C.A.; Member, Scientific Advisory Committee, Diamond Ordnance Fuze Laboratories; Member, Brittle Fracture Committee, National Research Council.

Jul/55

EDWARD WENK, JR.

Chairman
Department of Engineering Mechanics
Southwest Research Institute

B.E., The Johns Hopkins University, 1940
M.Sc., Harvard University, 1947
Ph.D. (Engineering), The Johns Hopkins University, 1950

Professional Fields: Applied Mechanics; Structural and Mechanical Engineering; Experimental Stress Analysis; Naval and Domestic Architecture; Research Laboratory Administration.

Related Special Abilities:

Research on thin shells and pressure vessels, scale model analysis; strength of ships, submarines and hydrofoils; gun recoil and operating systems; brittle fracture of materials; impact; high speed measurements and electric mechanical instrumentation; building design and construction.

Experience:

Chairman, Department of Engineering Mechanics, Southwest Research Institute, 1956 to present. Programs in Civil, Mechanical and Aeronautical Engineering; Domestic and Naval Architecture.

Head, Structures Division, David Taylor Model Basin, Washington, D. C., 1950 to 1956. Technical and administrative direction of Navy's program of research and development on ship structures, including investigation of strength, performance and derivation of design criteria for submarines, aircraft carriers, hydrofoils, and components such as catapults, nuclear boilers, sonar domes, and missile hangars. Responsible for structural tests of each new class ship. Consultant to NATO navies on submarine strength.

Head, Submarine Structures Branch, David Taylor Model Basin, 1949 to 1950. Directed fundamental and applied research on thin shell structures leading to new pressure hulls for Nautilus, Albacore, etc.

Supervisor, Structural Dynamics Section, David Taylor Model Basin, 1947 to 1949. Measurements and analysis of shock and impact and effects of enemy attack.

Supervisor and Project Manager, Turret Test Group, David Taylor Model Basin, 1942 to 1946. Developed scale models to predict ship strength and tests to evaluate automatic ordnance structures, recoil and operating mechanisms.

Structural Designer, Boston Naval Shipyard, 1941 to 1942. Hulls, cranes, mechanical equipment.

EDWARD WENK, JR. (Continued)

Architectural Designer, L. A. Meneffee, Architect, Baltimore, Maryland, 1937 to 1941. (Full and part time).

Special lecturer, Department of Mechanical Engineering, University of Maryland, 1954 to 1956.

Private consultant to various organizations on ship strength, experimental stress analysis, pressure vessels, instrumentation, 1954 to present.

Publications and Papers:

Over fifty publications in the fields of special abilities listed above; guest lecturer at MIT, Purdue, VPI, Johns Hopkins, Harvard.

Patents:

Several in fields of pressure, instrumentations and structural test facilities.

Awards:

Navy's Civilian Meritorious Service Award, 1946.

Member:

Society of Sigma Xi

Tau Beta Pi

Registered Professional Engineer, District of Columbia

American Society of Civil Engineers

National Vice-President, Society for Experimental Stress Analysis

Executive Committee and Chairman of Design Division, Pressure Vessel Research

Committee of Welding Research Council

Member of Advisory Group, Ship Structure Committee of National Research Council

September/56

BUELL W. BEADLE
Chairman



Department of Chemistry and Chemical Engineering

B.S. in Industrial Chemistry --1935
M.S. in Biochemistry --1938
Kansas State College
Ph. D. in Agricultural Biochemistry--1942
Purdue University

Special Fields:

Biochemistry, nutrition (plant, animal and human), agricultural chemistry, analytical chemistry.

Related Special Abilities:

Animal and vegetable fats and oils (their chemistry, autoxidation, and stabilization); development of antioxidants; stability of vitamins; chromatographic separation; high frequency dielectric heating.

Foodstuffs generally, including meats, fish, fruits, and vegetables; livestock feeds of various kinds, and by-product concentrates such as tankages, bone meals, fish meals, etc. Fertilizers, both liquid and solid; vitamins and vitamin concentrates.

Plant operation, organization, and sanitation.

Experience:

Chairman, Department of Chemistry and Chemical Engineering, Southwest Research Institute, 1956 to date. Directing and administering the research and development programs of the Institute in chemistry and chemical engineering.

Manager, Biochemistry Research, Southwest Research Institute, 1955. Planning, co-ordinating, administering, and executing the biochemistry research activities of the Institute.

Executive Vice-President and General Manager, Geo. W. Gooch Laboratories, Los Angeles, California, 1954 to 1955. Over-all management and direction of the laboratories, which serve the feeds, foods fertilizer and fats and oils industries. (Technical Director and Vice-President 1948 to 1950, same firm).

Head, Central Staff, U. S. Naval Ordnance Station, Inyokern (China Lake) California, 1952 to 1954. Served as top advisor to Station Management on all phases of management and technical planning problems, and supervised the activities of the Central Staff, which included the budget division, technical division, and management division. (Head, Technical Division of Staff, 1950 to 1952).

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BUELL W. BEADLE

Experience: (continued)

Research Chemist in charge of physical and analytical chemistry, American Meat Institute Foundation, Chicago, with faculty appointment, Department of Pharmacology, University of Chicago, 1942 to 1948. Various projects relating to the meat packing industry, including fats and oils (chemistry and autoxidation), antioxidants, stability of vitamins in meats, high frequency dielectric processing, etc.

Research Assistant, Purdue University, 1940 to 1942. Under Fellowship from General Foods Corporation, conducted studies on the carotenoids and related pigments.

Chemist, Control Division, Kansas State Board of Agriculture, 1935 to 1942 (on leave from 1940 to 1942), and member of faculty, Kansas State College and Kansas Agricultural Experiment Station. Supervised work and personnel in the laboratories of the Kansas State Board of Agriculture, and participated in research work at the Kansas Agricultural Experiment Station.

Publications:

About two dozen papers in the field of biochemistry, fats, and oils, vitamins, and sanitation. Co-author of book "Methods of Vitamin Assay".

Patents:

Several patents in field of antioxidants for fats, oils, and fatty foods, and on high frequency dielectric processing of foods.

Members:

Sigma Xi, Phi Kappa Phi, Phi Lambda Upsilon, Gamma Sigma Delta
American Oil Chemists' Society, Journal Committee and Reviewer for Journal, 1947 to 1950; National Convention Committee, 1946; Program Committee, 1946; Spectroscopy Committee, 1945 to 1950. Southwest Section American Oil Chemists' Society, Charter Member and first Chairman, 1955.
American Chemical Society, National Convention Committee, 1946.
Federated Societies for Experimental Biology and Medicine (American Society of Biological Chemists).
American Association for the Advancement of Science.
Institute of Food Technologists, Councillor Chicago, 1948, Local Committee 1946 to 1947.
Association of Vitamin Chemists; Finance Chairman 1944 to 1945; Delegate to Chicago Technical Societies Council, 1945; General Advisory Committee, Carotene Committee, and Style Committee for "Methods of Vitamin Assay" book.
Association of Food Industry Sanitarians.
U. S. Army Quartermaster Food and Container Institute, Scientific Advisory Board, World War II.

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JAMES M. SHARP

Manager, Special Projects
Department of Physics

B.S. , A & M College of Texas, 1940
M.A. , University of Texas, 1948
Ph.D. , University of Texas, 1950

Special Fields: Physical Measurements, Electro-Mechanical Components Development, Mechanical and Electrical Analog Computers, Low Temperature Equipment, Pressure Instruments, Timing Devices, Systems Analysis.

Related Special Abilities: Flight Research, Ballistics Research.

Experience:

Manager, Special Projects, Department of Physics, Southwest Research Institute, 1954 to date. Responsibility for overall guidance of research and development projects in acoustics, optics and analog computers.

Chief, Engineering Analysis Branch, Research Directorate, Air Force Special Weapons Center, 1953 and 1954. Responsibility for research and development projects in the fields of aerodynamics and liquefied gas production, storage, and transport.

Division Leader, Electro-Mechanical Division, Research, Sandia Corporation, 1950 to 1953. Responsibility for research and development projects in connection with component and system analysis, development, testing, and evaluation involving transducers, pressure instruments, computers, electro-mechanical power supplies, timing devices.

Research Scientist, Physics Department, University of Texas, 1947 to 1950. Research and development in the solution of electrical networks, electric wave filters, wave equations, and mathematical functions by mechanical computation.

Publications: Four classified reports - Sandia Corporation. Nine classified reports - Air Force Special Weapons Center. Two papers, Journal of Applied Physics in 1949 and 1950 on mechanical solution of network and wave filter problems. One ONR report, 1950, on applications of a mechanical harmonic synthesizer to solution of mathematical equations with application to physical problems.

Member: Sigma Xi, Sigma Pi Sigma, American Physical Society, RESA.

Rev. Apr/55